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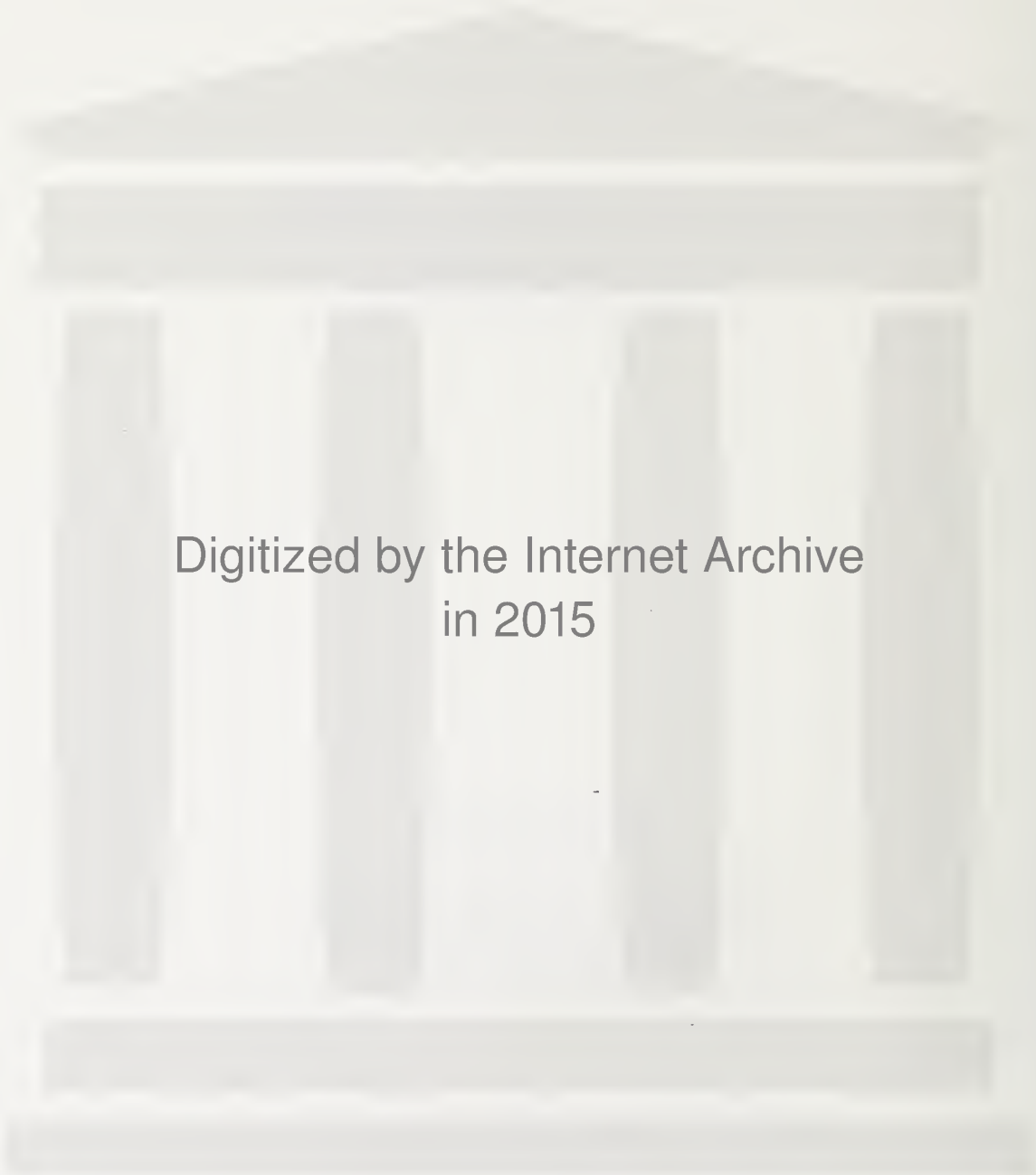

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SUMMARY

This report presents results of the Ministry's air quality assessment program for 1994 in northwestern Ontario. It includes data from eight communities where long-term monitoring is conducted.

BALMERTOWN

Levels of arsenic in tree foliage declined relative to previous years, but still remained above ministry guidelines at most sites. Arsenic in surface soils still exceeds the arsenic guideline. There is no discernable trend in arsenic levels over recent years.

DRYDEN

Odour levels in Dryden continued the excellent record of recent years. There were no exceedences of the Ontario interim standard for total reduced sulphur (TRS) during 1994.

FORT FRANCES

In 1994, there was no new off-property vegetation damage caused by air emissions from the local kraft pulp mill; foliar sodium levels were also low at all sampling sites around the mill, indicating good control of saltcake emissions from the mill's recovery furnace.

There was a general increase in total and insoluble dustfall in 1994 compared to 1993. Concentrations of suspended particulate matter essentially met Ministry objectives.

Odour levels near the local pulp mill declined sharply from 1993 to 1994. This improvement resulted from changes in operation of pollution control equipment at the mill. As well, the full time service of a major new pollution control device in early 1995 is expected to achieve still further gains in air quality.

MARATHON

There was general compliance with dustfall objectives near a wood-chip storage area at a local kraft pulp mill.

The number of exceedences of the TRS interim standard increased from 5 in 1993 to 18 in 1994. Compliance with the standard is required by June, 1996.

RED ROCK

Air quality with respect to odours worsened from 1993 to 1994. Weather conditions and equipment malfunctions at the local kraft pulp mill accounted for this decline.

SCHREIBER

The latest monitoring results near a transfer site for base-metal ore concentrates on CP Rail property in Schreiber have been somewhat inconclusive. Rigorous housekeeping seems to be needed to minimize dust emissions from the transfer site.

TERRACE BAY

Air quality in Terrace Bay was significantly better in 1993 than in 1994, with a sharp decrease in odour levels. Major pollution control efforts at the local kraft pulp mill are credited for this improvement.

THUNDER BAY

Dustfall at both monitoring sites near the Avenor pulp mill exceeded the annual objective, and there was an increase in exceedences of the monthly objective over 1993 data. There was substantial compliance with the annual objective for suspended particulate matter, and only a few exceedences of the daily objective.

Concentrations of carbon monoxide, nitrogen dioxide, ozone and sulphur dioxide consistently met Ministry objectives in Thunder Bay in 1994. Ozone slightly exceeded the Ontario objective during a few hours at two rural sites south of the city. The TRS interim standard near Avenor Inc. was exceeded 8 times. During the year, Thunder Bay's air quality index was "very good" or "good" for all but 28 hours, when it was "moderate" due to suspended particles (27 hours) or TRS (1 hour).

With the exception of one sample, urban concentrations of organic compounds were well within Ontario objectives.

Airborne dust levels near Thunder Bay Terminals Limited substantially complied with Ontario's monthly and annual objectives for dustfall and suspended particulate matter in 1994.

INTRODUCTION

1.0 PURPOSE OF MONITORING PROGRAM

The Ontario Ministry of Environment and Energy assesses air quality throughout the province. Monitoring networks record outdoor concentrations of pollutants that may adversely affect human health, animal life, vegetation, and the use and enjoyment of property. These surveys document compliance with air quality objectives, and determine long-term air quality trends. Pollution sources are identified and the results of pollution control measures are assessed.

In northwestern Ontario, air quality surveys first began in 1963, to measure airborne dust in the City of Thunder Bay. In 1994, the regional monitoring network included seven communities and two rural sites, with a total of 54 monitoring devices (Tables 1 and 2). Ontario Hydro also operated an air quality network in Thunder Bay.

Data from air quality and meteorological instruments are supplemented by vegetation, soil and snow sampling studies, and by predictions of pollutant levels with mathematical models.

Monitoring in the region is mostly conducted in urban areas and near industrial sources of air pollution (eg. mines, pulp and paper mills). Therefore, problem situations described in this report are not typical of the region, where air quality is generally excellent.

Acid rain and fallout of toxic pollutants (eg. metals, pesticides) are major environmental issues in eastern North America and in parts of Europe. Ontario, through its Acidic Precipitation in Ontario Study, is assessing the effects of fallout of acidic and toxic substances throughout the province. The Ministry's Northern Ontario Region participates in this program by operating precipitation and toxics deposition samplers. The findings of these studies are reported elsewhere.

2.0 POLLUTANTS AND THEIR MEASUREMENT

2.1 Particulate Matter

There are many man-made and natural sources of airborne particulate matter. Typical man-made sources in northwestern Ontario are forest product industries and mining operations. Wind-blown particles from stored materials and roadways are examples of secondary sources. Particulate matter may also be emitted from agricultural activity, forest fires, volcanoes, and dust storms. Depending on particle size and chemical makeup, particulate matter may harm health and vegetation, affect visibility, and cause local nuisance problems. In Ontario, particulate matter is measured as dustfall, total suspended particulate matter (TSP), inhalable particulate matter (IPM), and soiling index.

Dustfall is particulate matter that settles out from the air by gravity. Open-top containers (dustfall jars) are exposed for 30-day periods and the collected matter is weighed.[1] The monthly air quality objective (maximum acceptable limit) for dustfall is 7 $g/m^2/30$ d (grams per square metre during 30 days). The annual objective is 4.6 $g/m^2/30$ d. Dustfall measures the fallout of particulate matter from local sources, including dust from construction or from vehicles. It is usually not a health-related pollutant, but may be a nuisance because of soiling effects. Dustfall in 1994 was measured at 10 Ministry sites in northwestern Ontario. James River-Marathon, Ltd. also operated a four-site dustfall network near its Marathon pulp mill.

Total suspended particulate (TSP) matter comprises particles of small size which remain entrained in the air for long periods. This material, from local or distant sources, is measured with a high-volume sampler for a 24-hour period every sixth day.[2] The difference in the weight of a fibreglass filter before and after exposure determines the quantity of particulate matter collected. The air quality objective is 120 $\mu g/m^3$ (micrograms per cubic metre of air sampled) averaged over 24 hours, and 60 $\mu g/m^3$, annual geometric mean. TSP was monitored at four sites in 1994.

Inhalable particulate matter comprises particles smaller than 10 μm (micrometres) in diameter. It is measured with a standard high-volume sampler fitted with a size-selective inlet. Samples are collected on a quartz filter exposed for a 24-hour period every sixth day. An Ontario air quality objective for inhalable particulate matter is being developed. In 1994, IPM was measured in two communities in the region (Thunder Bay and Fort Frances).

Soiling index is a measure of the soiling or darkening properties of very small airborne particles, and is expressed as coefficient of haze (COH). It is related to the concentration of respirable particulate matter. A measured volume of air passes through a paper tape which moves through an automated sampling unit to produce a reading every hour. The reduction of light transmitted through the tape is expressed as coefficient of haze (COH) per 1,000 linear feet of air sampled. The Ontario objective is 1.0 COH, 24-hour average, and 0.5 COH, annual average. There are currently three COH measurement sites in the region.

2.2 Gaseous Pollutants

2.2.1 Carbon Monoxide (CO)

Carbon monoxide is a colourless, odourless gas. Its primary source (about 80%) is motor vehicles. A secondary source is fossil fuel combustion. As the number of vehicles in northwestern Ontario is small relative to other parts of the province, carbon monoxide is not a problem pollutant in this region. Elevated concentrations of carbon monoxide cause well-known health effects. The maximum acceptable level in Ontario is 30 ppm (parts of carbon monoxide per million parts of air), 1-hour average, and 13 ppm, 8-hour average. This pollutant is measured with a continuous analyzer[3] at two locations in Thunder Bay.

2.2.2 Nitrogen Oxides (NO_x)

Nitric oxide (NO) and nitrogen dioxide (NO_2) are together termed nitrogen oxides (NO_x). Both NO and NO_2 may be emitted from natural and man-made sources. High-temperature fuel combustion, which occurs in vehicle engines and thermal power plants, is the main man-made emission source. At concentrations measured in ambient air, NO has no known adverse effects. NO may, however, oxidize to NO_2 which, in turn, may adversely affect health and visibility. NO_2 also reacts with hydrocarbons in sunlight to form ozone. It may also combine with water to form nitric acid, a component of acid rain. In northwestern Ontario, nitrogen oxides are monitored with a continuous analyzer[4] at one location in Thunder Bay. The air quality objectives for NO_2 in Ontario are 0.2 ppm, 1-hour average, and 0.1 ppm, daily average.

2.2.3 Ozone (O_3)

Ozone occurs naturally and beneficially in the upper atmosphere. Near the ground, it is a product of reactions between nitrogen oxides and hydrocarbons in the presence of sunlight. If present at high concentrations, it may affect health and vegetation. Since ozone-forming compounds are not emitted in large amounts in northwestern Ontario, elevated ozone readings, if present, would suggest long-range transport from outside the region. The Ministry measures ozone with continuous analyzers[5] at three sites in northwestern Ontario and one in northern Minnesota. The Ontario air quality objective for ozone is 0.08 ppm, averaged over one hour.

2.2.4 Sulphur Dioxide (SO_2)

Sulphur dioxide is one of the world's major atmospheric pollutants and has many well-known effects on health, vegetation and property. It is also one of the main contributors to acid rain. In northwestern Ontario, the principal SO_2 sources are small compared to those in some other parts of the province. The main regional emitters of SO_2 are, in approximate descending order of importance, Ontario Hydro generating stations (Thunder Bay and Atikokan), sulphite pulp mills, and industrial boilers. The Ministry measures sulphur dioxide with a continuous analyzer[6] at one location in Thunder Bay; Ontario Hydro has three SO_2 monitors in Thunder Bay. There are three air quality objectives for this pollutant: 0.25 ppm, hourly average; 0.10 ppm, 24-hour average; and 0.02 ppm, annual average.

2.2.5 Total Reduced Sulphur (TRS)

Total reduced sulphur comprises a group of sulphur-containing gases found in emissions from kraft pulp mills, which are the sole significant TRS sources in the region. At very low concentrations, TRS results in offensive odours. Higher levels may cause temporary discomfort to sensitive individuals. In Ontario, an interim standard of 27 ppb (parts of TRS, expressed as hydrogen sulphide, per billion parts of air), averaged over one hour, is used as an air quality objective near kraft pulp mills. TRS is measured with continuous analyzers[7] at 11 sites in northwestern Ontario.

2.2.6 Organic Compounds

The Ministry operates a small provincial network for measuring organic compounds. The compound groups included in this network are dioxins/furans, VOCs (volatile organic compounds) and PAHs (polynuclear aromatic hydrocarbons). These pollutants are often called "air toxics", and are of special interest as possible health risks in urban areas. The VOC group in the Ministry's air monitoring program currently includes 35 compounds. There are 44 PAH compounds analyzed.

In northwestern Ontario in 1994, the Ministry operated a VOC and a PAH monitor in Thunder Bay, and a VOC sampler in Fort Frances. VOC and PAH samples are collected over a 24-hour period every 12 days.

2.3 Air Quality Index (AQI)

Since early June, 1988, an Air Quality Index (AQI) has been issued eight times daily for Thunder Bay and other cities in Ontario. The AQI is based on readings for six pollutants: carbon monoxide, ozone, nitrogen dioxide, suspended particles (soiling index), sulphur dioxide, and total reduced sulphur. An AQI of 0 to 15 is "very good", 16 to 31 is "good", 32 to 49 is "moderate", 50 to 99 is "poor", and more than 99 is "very poor".

In September 1989, one of the Fort Frances monitoring stations was designated an AQI site. Measurement of suspended particles was added at this station in September, 1991, and ozone in July, 1993.

2.4 Miscellaneous

The occurrence and effects of some of the foregoing pollutants, plus others, may be assessed by vegetation injury and by determining contaminant levels in vegetation, soil and snow. Standard Ministry procedures [8,9,10] are followed in collecting and analyzing these types of samples. Arsenic, chloride, fluoride,[11] sulphur and heavy metals are typical pollutants examined this way. Their levels in a study area are compared with normal background values at sites unaffected by pollution. Contaminant guidelines developed by the Ministry for vegetation, soil and snow are used in this report. The guidelines are based on the upper limit of "normal" elemental concentrations across the province. Exceedence of a guideline may indicate a contamination problem. However, it is not a violation of Ministry regulations, nor does it necessarily imply health or environmental effects.

Most analyses for regional investigations of vegetation, soil and snow are carried out at the Ministry's Thunder Bay laboratory. The Ministry's Toronto laboratory analyses suspended and inhalable particulate matter, plus sulphur and halides (chloride and fluoride) in vegetation and soil. The Toronto laboratory also analyses VOC (volatile organic compounds) and PAH (polynuclear aromatic hydrocarbons). A private laboratory carries out most of the tests for samples of dustfall.

RESULTS

3.0 BALMERTOWN

Since 1971, the Ministry has conducted air quality surveys near two gold mines in Balmertown. For many years, the Campbell Mine (Placer Dome Inc.) and the Goldcorp Inc. mine (formerly Dickenson Mines Limited), emitted significant amounts of airborne arsenic trioxide and sulphur dioxide from ore roaster stacks. In the mid-1970's, both mines reduced arsenic emissions by more than 95 percent. In early 1980, Dickenson shut down its roaster. The Campbell Mine suspended concentrate roasting in July 1991. In 1994, the Ministry conducted soil, vegetation and snow sampling surveys, in the Balmertown townsite and near the two operating gold mines (Figure 1), to assist Campbell Mines in a special risk assessment study of arsenic in old mine tailings in the 6th and 7th Street area.

3.1 Terrestrial Assessment

Levels of arsenic in tree foliage near the mines (Table 3) and in the townsite (Tables 3 and 4) declined in 1994 compared to levels in previous surveys, however arsenic levels remained above established guidelines at most sampling sites. Levels of arsenic in surface soils exceeded established guidelines at all sites in 1994. Over the past 21 years, historical levels of arsenic in surface soils showed no apparent trend (see Table 5) although levels are increasing at Station 17 possibly due to wind erosion from the tailings area. Arsenic concentrations were usually lower in subsurface soils, as expected from airborne deposition. Arsenic in snow shows no real trend in recent years (Table 6).

Although current stack emissions of arsenic have ceased, past contamination of surface soil, wind erosion of tailings and the unprotected storage of gold concentrates may result in ongoing elevated arsenic in the townsite of Balmertown and local environment.

4.0 DRYDEN

For several years, the Ministry has monitored air quality near a bleached kraft pulp mill in Dryden. Abatement action, process changes, and mill modernization have resolved the air quality concerns of the 1970s and early 1980s. Currently, the Ministry monitors odour levels at one site in the town centre.

4.1 Odour Levels

At the TRS monitoring station(61027, Figure 2), there were no exceedences of the interim standard for TRS in 1994 (Table 7). The annual average was similar to that in recent preceding years.

5.0 FORT FRANCES

During its first years of operation, emissions from a bleached kraft pulp mill in Fort Frances resulted in particulate fallout and odour problems in a nearby residential area. In the late 1970s, some emission reductions were achieved. In 1980, a Control Order was issued for further pollution controls. The mill also created a "buffer zone" through purchase of adjacent residential land.

Air quality studies in Fort Frances have been conducted regularly since 1972 near the Canadian mill, and periodically since 1974 around a similar nearby plant owned by the parent corporation on the U.S. side of the border (see Figure 3).

5.1 Vegetation Assessment

In 1994, there was no visible air pollution injury to vegetation around the Fort Frances mill (Figure 4). Sodium in tree foliage was low in 1994, as it has been for the past few years. Table 8 compares the data from recent years with sodium levels in 1980, a year typical for average conditions from 1975 to 1986. Snow sampling has also confirmed that sodium (and sulphate) fallout have been low in recent years. Reduced emissions of saltcake from the Fort Frances mill are credited for this improvement.

Chloride was also tested in tree foliage and found to be not significantly elevated above concentrations expected in urban areas.

5.2 Particulate Matter

Dustfall results for 1994 are summarized in Table 9. In 1994, there was a general increase in the level of total and insoluble dustfall compared to 1993. The annual air quality objective for dustfall was met at three of the six monitoring sites off mill property. At three other off-property sites and on-site on mill property, annual dustfall slightly to moderately exceeded the objective. At one on-property site, dustfall was significantly above the desirable limit for the yearly average. At off-property sites, 15 of 72 monthly samples exceeded the monthly dustfall objective. The predominant component of the dustfall was wood fibre. Average dustfall during the past eleven years (Figure 5) follows a steady decline until 1994. The low level of saltcake in dustfall in recent years has mirrored the sodium data for vegetation.

In 1994*, average total suspended particulate matter (TSP) at the monitoring site near the mill (station 62035) was 38 $\mu g/m^3$, well below the annual provincial objective of 60 $\mu g/m^3$. There were no exceedences of the daily objective at this location. All but two of the 49 daily readings at this site met the 24-hour objective. The average TSP at the Fort Frances cemetery (station 62032) was 18 $\mu g/m^3$.

Measurement of inhalable particulate matter (IPM) began in Fort Frances (station

62035) in July, 1992. In 1994*, total IPM varied from 5 to 50 $\mu g/m^3$, 24-hour average, with an arithmetic mean of 21 $\mu g/m^3$. An Ontario objective for IPM is under development. In the United States, standards range from 50 to 150 $\mu g/m^3$ for single samples, and from 30 to 50 $\mu g/m^3$ for annual averages.

Levels of suspended particles (soiling index), measured on a real-time basis at the AQI station (62030), met provincial objectives during the year.

5.3 Odour Levels

The number of exceedences of the TRS interim standard declined sharply from 1993 to 1994 at monitoring site 62030 near the Rainy River Forest Products mill (formerly Boise Cascade Canada) (Table 10). Changes in operation of pollution control equipment at the mill are believed to be responsible for this improvement.

At station 62032 (cemetery), the number of TRS exceedences was the same in 1993 and 1994. At least half of the exceedences in both years were linked to emissions from the Boise Cascade mill in International Falls. Minnesota Pollution Control Agency was promptly notified of these episodes for appropriate follow-up action. At the Ministry's two other TRS measurement stations in Fort Frances, there was a minor improvement at the LaVerendrye Hospital site (Table 11), probably reflecting the improvement noted above for station 62030, nearer the mill. At the Eighth Street lagoon (Table 11), TRS exceedences increased from 1993 to 1994. Most of the high readings at this site in 1994 occurred in the spring and summer months.

Data from the monitoring station near the Civic Centre (station 62030) has been published daily as an Air Quality Index (AQI) since November, 1989. During 1994 there were 508 hours of "moderate" air quality (compared with 786 hours in 1993), and 76 hours of "poor" air quality (329 hours in 1993). At all other times, the AQI was "very good" or "good". Except for 3 hours caused by suspended particles, TRS was responsible for all occurrences of moderate or poor air quality. The maximum AQI during the year was 54.

A major pollution control device ("condensate stripper") was placed in full-time service at the Rainy River mill in early 1995. Further improvement of Fort Frances air quality, particularly in the Eighth Street area, should result from this initiative.

5.4 Ozone

During 1994, ground-level ozone in Fort Frances met the Ontario objective at all times.

* Data for May 1994 not included in these results due to technical problems at the laboratory.

5.5 Chlorine

A continuous chlorine analyzer was added to the monitoring site at LaVerendrye Hospital in September, 1993. No elevated readings were recorded in 1994.

5.6 Volatile Organic Compounds (VOCs)

Measurement of VOC compounds began in Fort Frances at station 62030 on April 8, 1994. One 24-hour sample is collected every 12 days. The results for 1994 showed that all VOC compounds were well within acceptable limits.

6.0 MARATHON

The Ministry currently maintains one air quality monitoring station in Marathon (Figure 6) to monitor odour levels near the kraft pulp mill operated by James River-Marathon, Ltd. James River also has dustfall jars at four sites to measure fallout of particulate matter near a storage area for wood chips.

6.1 Particulate Matter

For 1994, the company's data revealed that 8 of 34 monthly dustfall samples at sites off company property moderately exceeded the maximum acceptable limit. The annual objective was met at one of the three off-property sites, and slightly exceeded at the other two. Fallout from the wood chip piles did not contribute significantly to local dustfall, although intermittent dustfall events may be a nuisance in some months. No complaints about the chip piles were received during the year.

6.2 Odour Levels

TRS exceedences (Table 12) increased from 1993 to 1994. The TRS interim standard was exceeded 18 times in 1994, compared with 5 the preceding year. Most of the elevated readings in 1994 occurred in June and July. A Certificate of Approval requires James River to comply with the interim standard by June 30, 1996. TRS emission tests will be carried out before that date.

7.0 RED ROCK

The Ministry operates an air quality analyzer in the Town of Red Rock to measure odours near a linerboard mill operated by Domtar Inc. (Figure 7).

7.1 Odour Levels

There were 250 exceedences of the interim standard for TRS in 1994, much higher than the 99 recorded in 1993 (Table 13). Part of the reason for the decline in air quality was an increase in wind direction frequency from the Domtar mill to the TRS monitor, particularly in the last three months of the year. Another contributor was an increase in malfunction of mill equipment.

8.0 SCHREIBER

In response to concerns about dust emissions from an ore concentrate transfer facility on CP Rail property in Schreiber, the Ministry has been conducting air quality studies since 1988. The zinc and copper concentrates are produced at the Inmet Mining Corp. base metal mine, 20 km northwest of Schreiber.

8.1 Particulate Matter

The latest published data[12] reveals that levels of cadmium, copper and zinc in moss exposed during the summer of 1993 declined in comparison with previous years. However, metal levels in snow in early 1994 increased, compared with past years. Rigorous housekeeping during cold weather periods appears to be needed to minimize the spread of concentrate dust.

9.0 TERRACE BAY

The Ministry's monitoring program in Terrace Bay is directed toward measurement of odour levels in the townsite and near a secondary treatment system (lagoon) adjacent to the Kimberly-Clark Forest Products Inc. kraft pulp mill (Figure 8).

9.1 Odour Levels

As Table 14 reveals, air quality improved at both monitoring sites from 1993 to 1994. Station 63093, near the lagoon, was relocated to a residential area in November, 1994, and was assigned the number 63092. (see Figure 8).

Several projects, with a total cost of $5 million, were carried out by Kimberly-Clark in 1994 to reduce TRS emissions. The air quality results from the Ministry's two monitoring sites confirmed the benefits of this action.

10.0 THUNDER BAY

In 1994, the Ministry operated three monitoring stations in Thunder Bay. The locations of these sites, plus those operated by Ontario Hydro, are shown in Figure 9. One station, 63200, records all continuously measured pollutants. These are: sulphur dioxide,

ozone, carbon monoxide, nitrogen oxides, particulate matter (soiling index) and total reduced sulphur. An hourly Air Quality Index (AQI) is issued for this site. This station is also part of Environment Canada's National Air Pollution Surveillance network. Ontario Hydro operated three sulphur dioxide monitors in the city during the year (stations 63041, 63044 and 63048, Figure 9).

10.1 Particulate Matter

10.1.1 Dustfall

A data summary appears in Table 15 for the two sites where dustfall measurements were carried out in 1994. Out of 24 samples at these two sites, there were eight exceedences of the monthly dustfall objective compared to 2/24 in 1993. The annual objective was not met at either site. The laboratory is unable to provide data on composition of the dustfall material. As Figure 10 shows, there has been a steady improvement in dustfall over the years near the mill, until a moderate increase in 1994.

10.1.2 Suspended Particulate Matter (TSP) and Soiling Index

There were two samples, out of 119 for the year*, which exceeded the 24-hour objective for TSP (Table 16). The annual objective was met at both monitoring sites. The particulate captured in this technique is analyzed for other parameters as well. Concentrations of lead also met objectives. Levels of sulphate and nitrate, which are influenced by long-range transport, varied considerably.

At both Thunder Bay monitoring sites, soiling index met the daily and annual air quality objectives.

10.1.3 Inhalable Particulate Matter (IPM)

IPM sampling began at station 63200 (Walsh and James Street) in July, 1989. In 1994*, IPM ranged from 5 to 38 $\mu g/m^3$, with an arithmetic mean of 19 $\mu g/m^3$. At present, Ontario is developing an objective for IPM (see 4.2).

10.2 Gaseous Pollutants

10.2.1 Carbon Monoxide (CO), Nitrogen Dioxide (NO_2) and Ozone (O_3)

Throughout the year, carbon monoxide was well below the maximum acceptable limit for 1-hour and 8-hour averages at the two Thunder Bay monitoring stations. Nitrogen dioxide met the 1-hour and 24-hour objectives. Ozone met the provincial 1-hour objective of 0.08 ppm at all times in Thunder Bay. At one of the regional rural sites (Fernberg Road, Minnesota), the ozone objective was exceeded during 7 hours while at the other rural site

* Data for May 1994 not included in these results due to technical problems at the laboratory.

(Cloud River), the provincial objective was exceeded during one hour. Ozone, a long-range transport pollutant, is not currently considered a problem in northwestern Ontario. Summary figures for carbon monoxide, nitrogen dioxide and ozone are presented in Table 17.

10.2.2 Sulphur Dioxide (SO_2)

The principal industrial sources of sulphur dioxide in Thunder Bay are a 310-megawatt, lignite-fired, electric generating station and three pulp and paper mills. Collectively, these sources are relatively small; total SO_2 emissions in Thunder Bay are estimated to be less than 12 metric tons per day. The network of four SO_2 monitors (three belonging to Ontario Hydro and one owned by the Ministry) showed full compliance for all SO_2 air quality objectives in 1994 (Table 18).

10.2.3 Total Reduced Sulphur (TRS)

There were no exceedences of the TRS interim standard in 1994 at the Thunder Bay Air Quality Index station (James and Walsh). At the Montreal Street site (station 63046, Figure 8) which is closer to the Avenor kraft pulp mill, there were 8 exceedences (Table 19).

10.2.4 Organic Compounds

The Ministry operates a sampler for PAH (polynuclear aromatic hydrocarbons) compounds at its main monitoring station (63200) in Thunder Bay. The purpose of this sampling program is to establish a data base for general urban levels of PAHs, some of which are suspected causes of cancer. On one sampling date in 1994, benzo(a)pyrene was slightly above the air quality objective. With this exception, all PAH compounds met current objectives in the 30 samples obtained during the year.

Urban concentrations of VOCs (volatile organic compounds), have been measured at station 63200 since October, 1990. Toxic organic compounds such as benzene, xylene, and toluene are included in this survey. VOC levels in 1994 were found to be well within Ontario objectives.

10.3 Air Quality Index (AQI)

An hourly AQI was determined for the six pollutants continuously monitored at station 63200. During 1994, the AQI was very good or good except during 28 hours, when it deteriorated to the moderate category. Suspended particles (measured as coefficient of haze) were responsible for all but one hour of moderate AQI; one hour was due to TRS. The maximum AQI during the year was 44.

10.4 Special Studies

10.4.1 Thunder Bay Terminals Limited

A report on monitoring near Thunder Bay Terminals Limited[13] showed that provincial air quality objectives were substantially met in 1994. Western coal and potash are the main products handled at this transfer facility. There has been no increase in dust levels at off-property monitoring sites since shipments began in 1978.

OTHER REPORTS ISSUED IN 1994

The following is a list of other reports released by the regional air resources unit during 1994. For each document, a brief summary is included. Items already listed under "References" for this report (see pages 14-15) are excluded.

- Air quality, northwestern Ontario, 1993.
  Results of the Ministry's air quality assessment program for 1993 in northwestern Ontario are presented.

- Air quality, Kenora District, quarterly reviews.
  Quarterly data summaries were issued for the periods 1993; January - March, 1994; April - June, 1994; July - September, 1994.

- Air quality, Thunder Bay District, quarterly reviews.
  Quarterly data summaries were issued for the periods 1993; January - March, 1994; April - June, 1994; July - September, 1994.

- Air quality data, Wawa, 1993-94
  Presents interim data on sulphur dioxide and particulate matter from June, 1993 to June, 1994.

- Snow sampling survey near Grant Forest Products Corp., Englehart, 1994.
  No major change was found in snow chemistry, compared with a similar survey in 1992.

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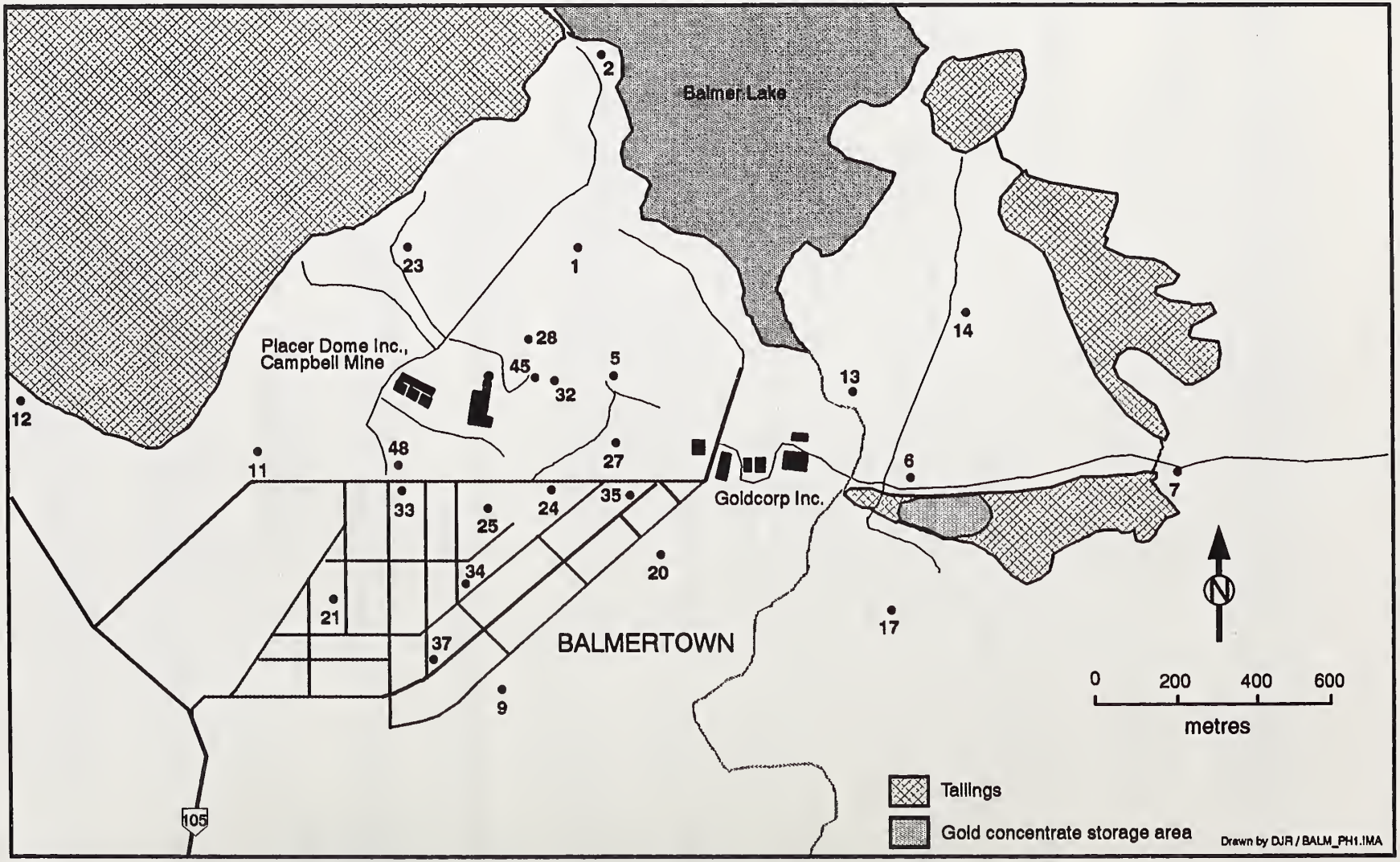

Figure 1. Environmental sampling sites, Balmertown, 1974-1994.

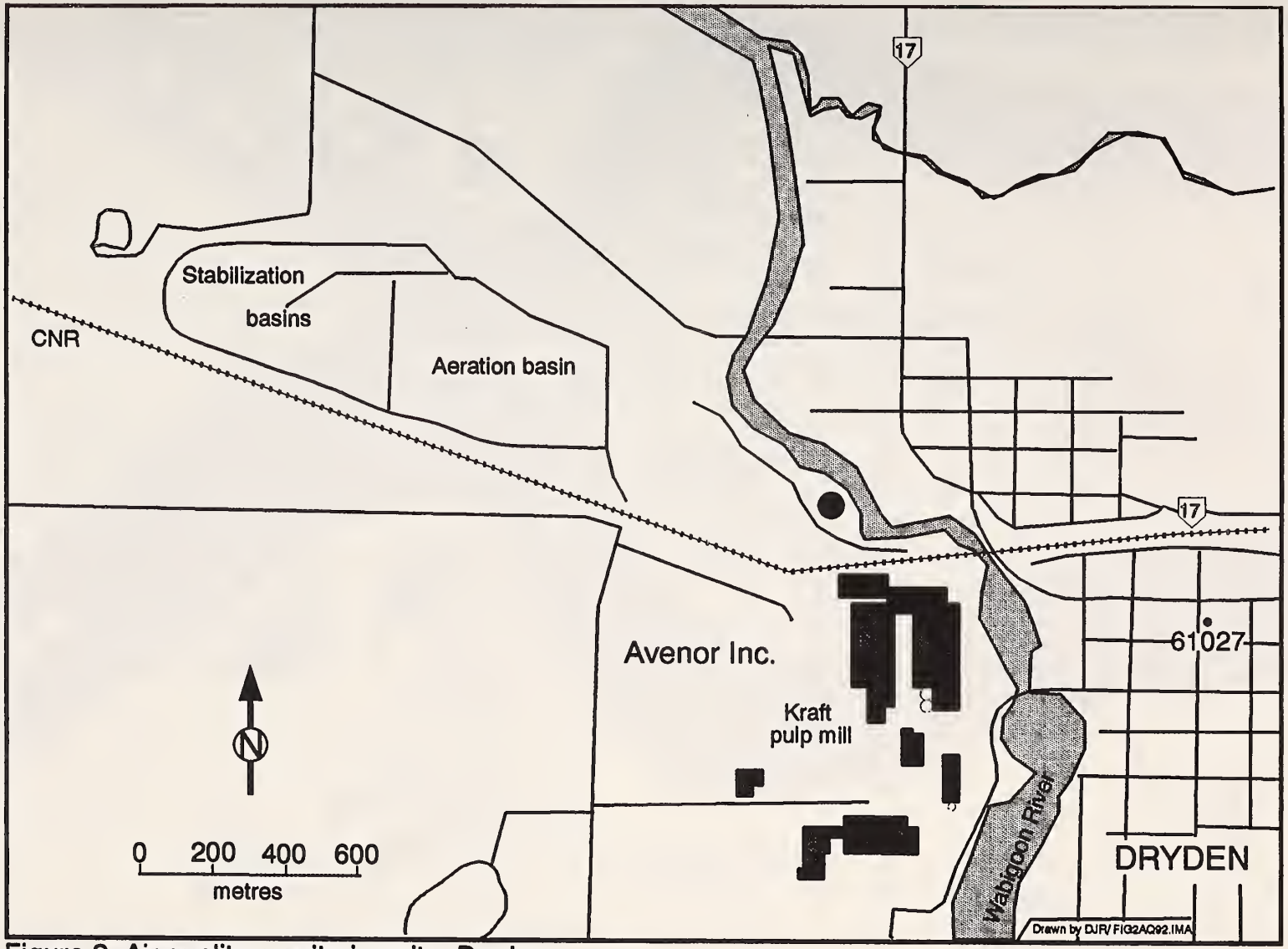

Figure 2. Air quality monitoring site, Dryden.

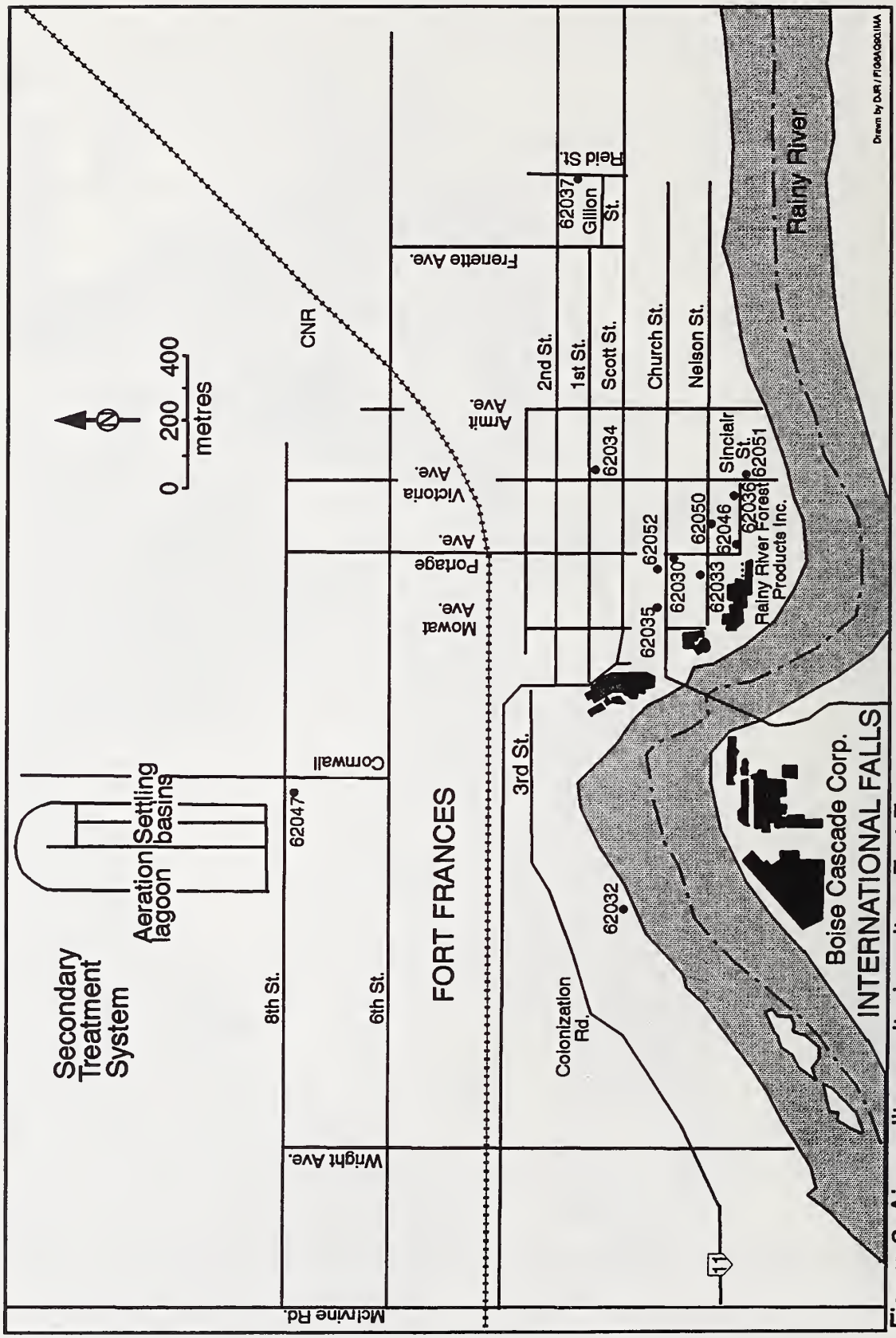

Figure 3. Air quality monitoring sites, Fort Frances.

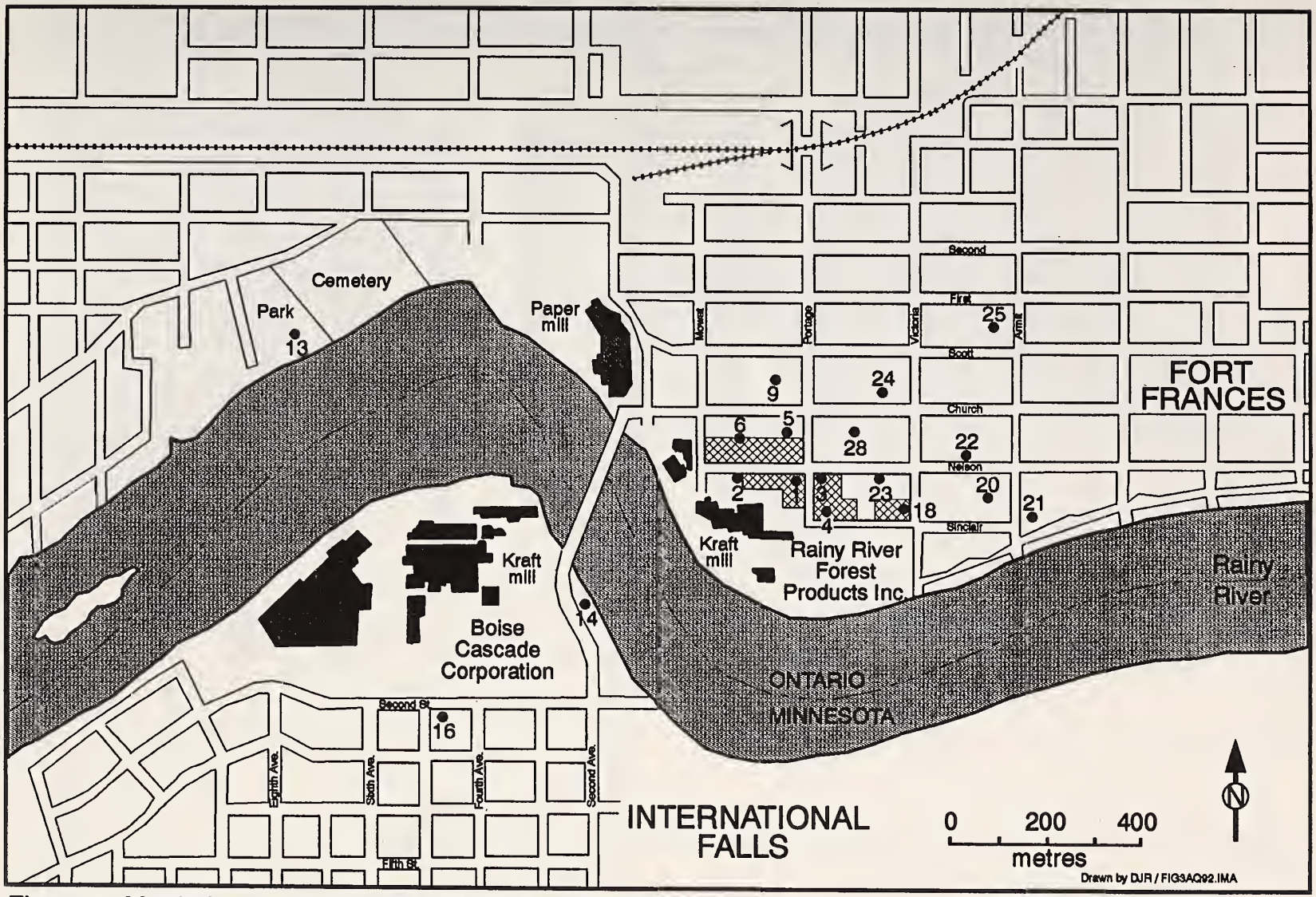

Figure 4. Manitoba maple sampling sites, Fort Frances.

Buffer zone

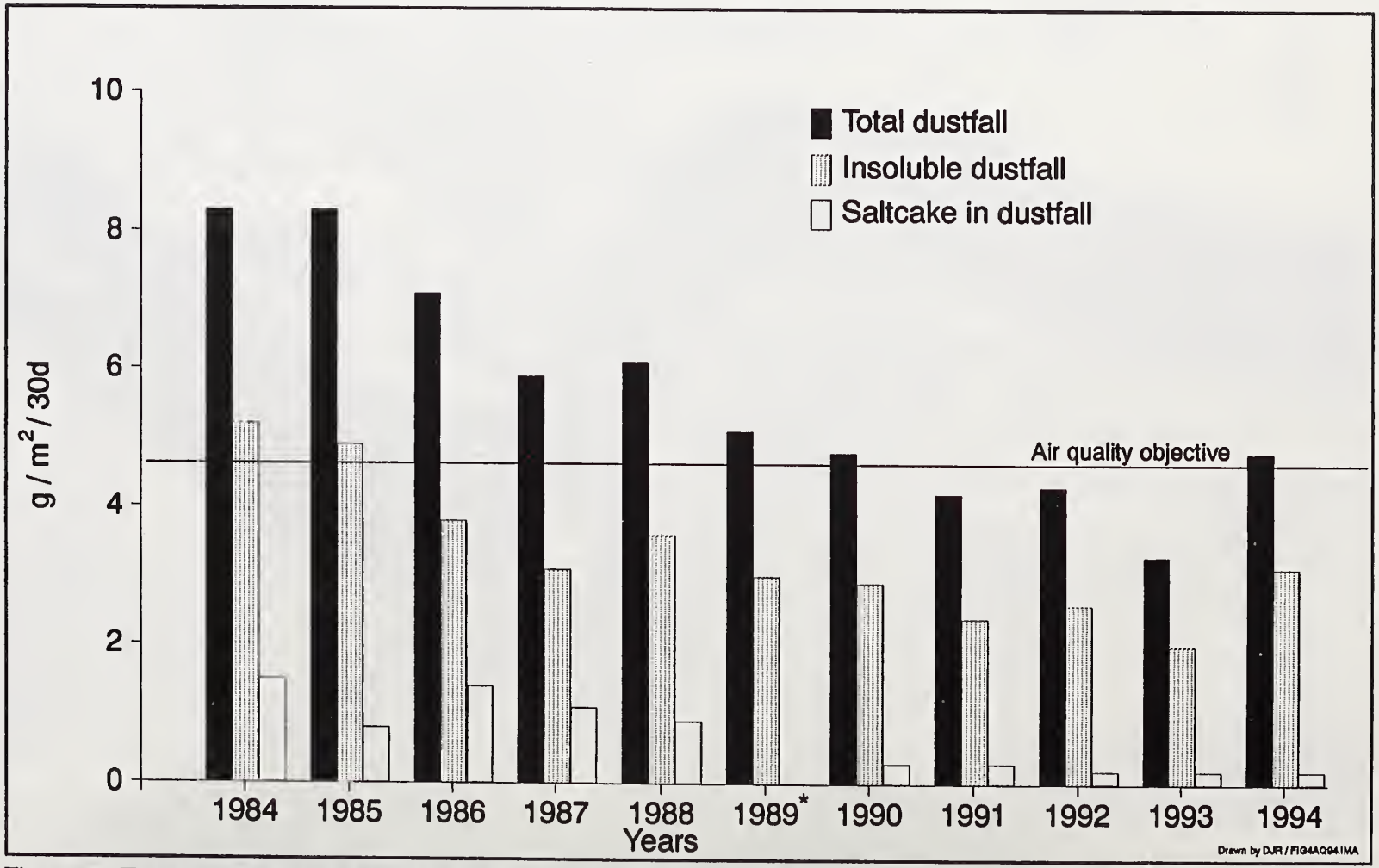

Figure 5. Total dustfall, insoluble dustfall, and saltcake in dustfall, Fort Frances (average of six sites off mill property).
* Saltcake data not available.

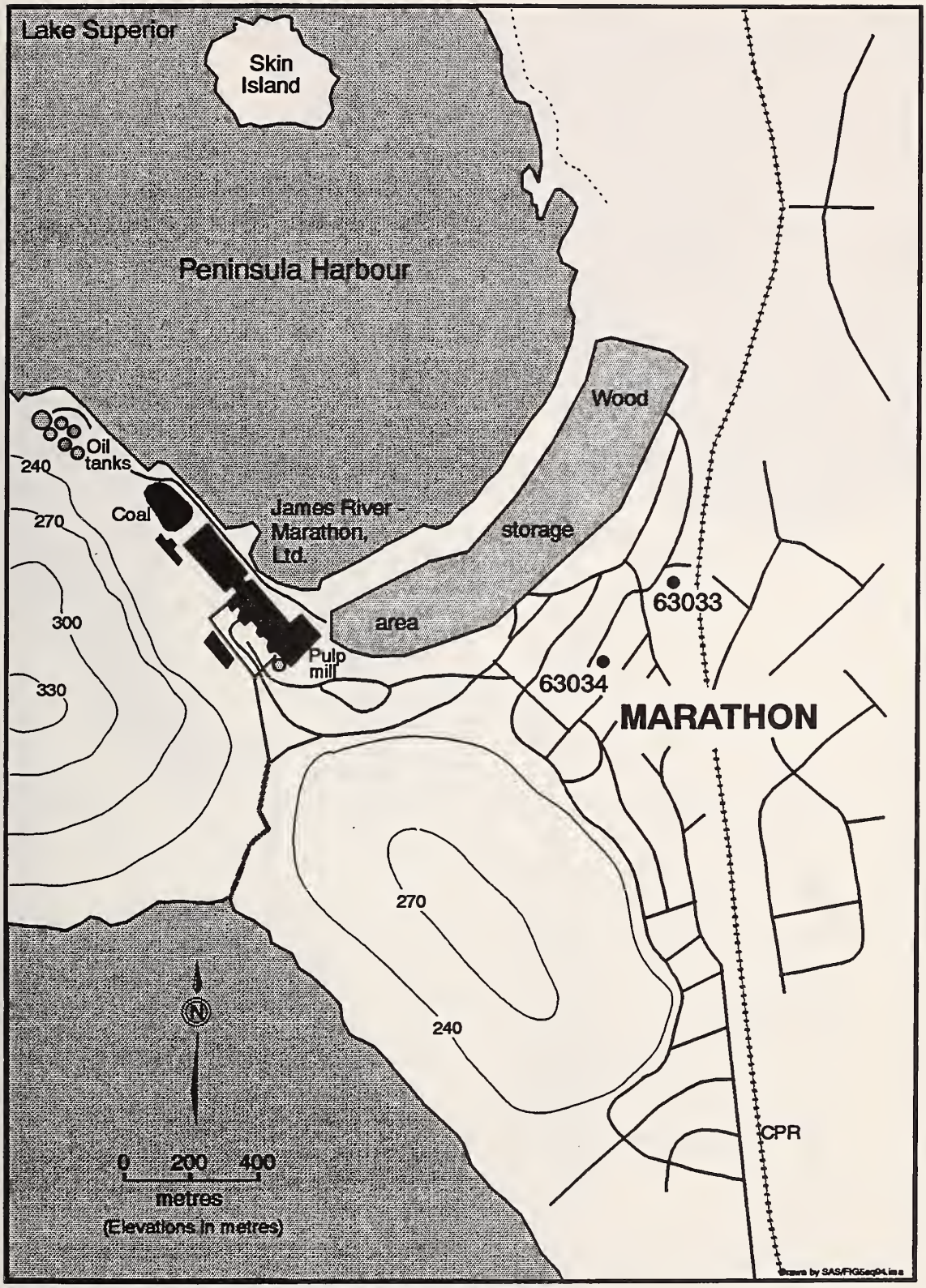

Figure 6. Air quality monitoring stations, Marathon.

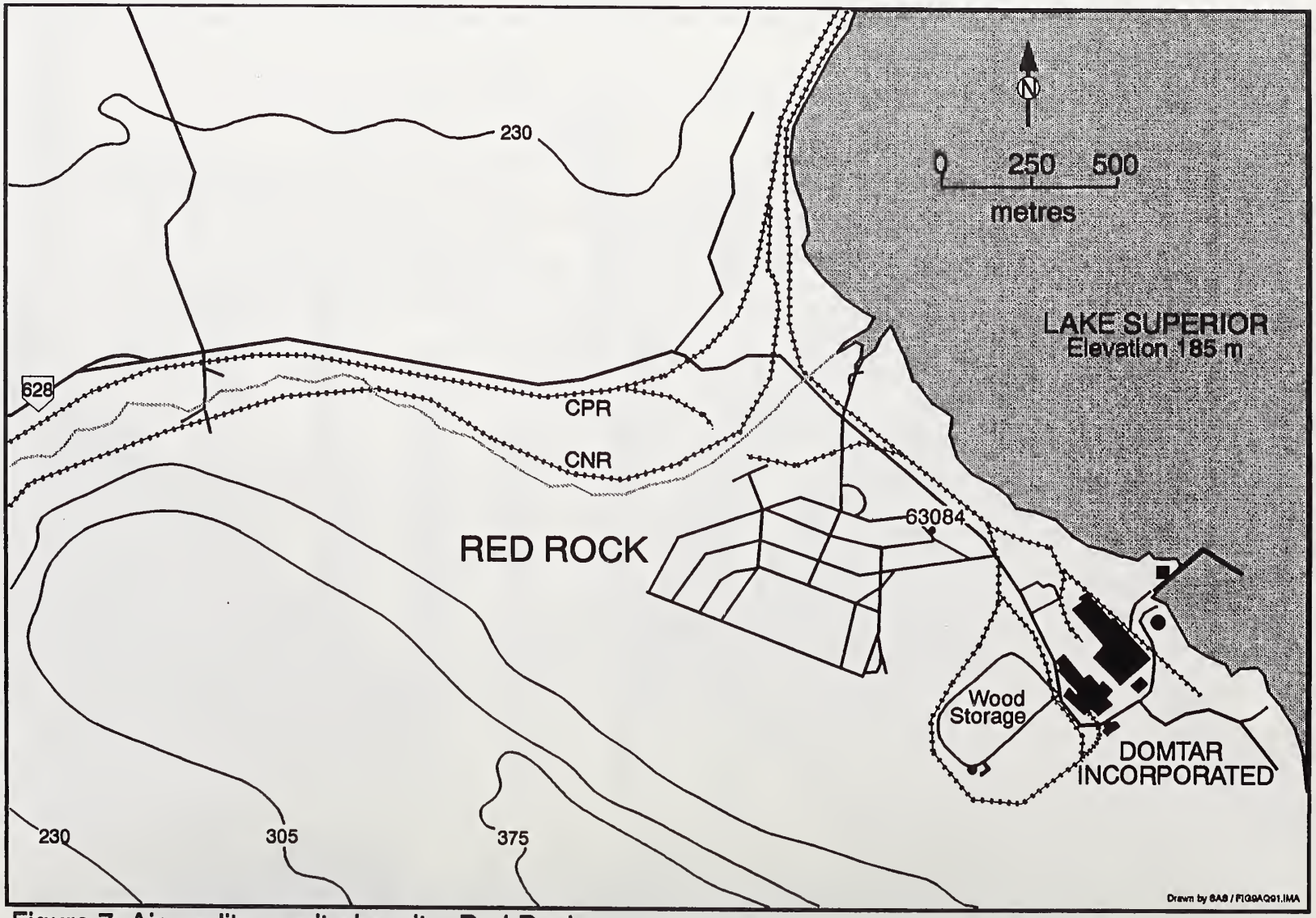

Figure 7. Air quality monitoring site, Red Rock.

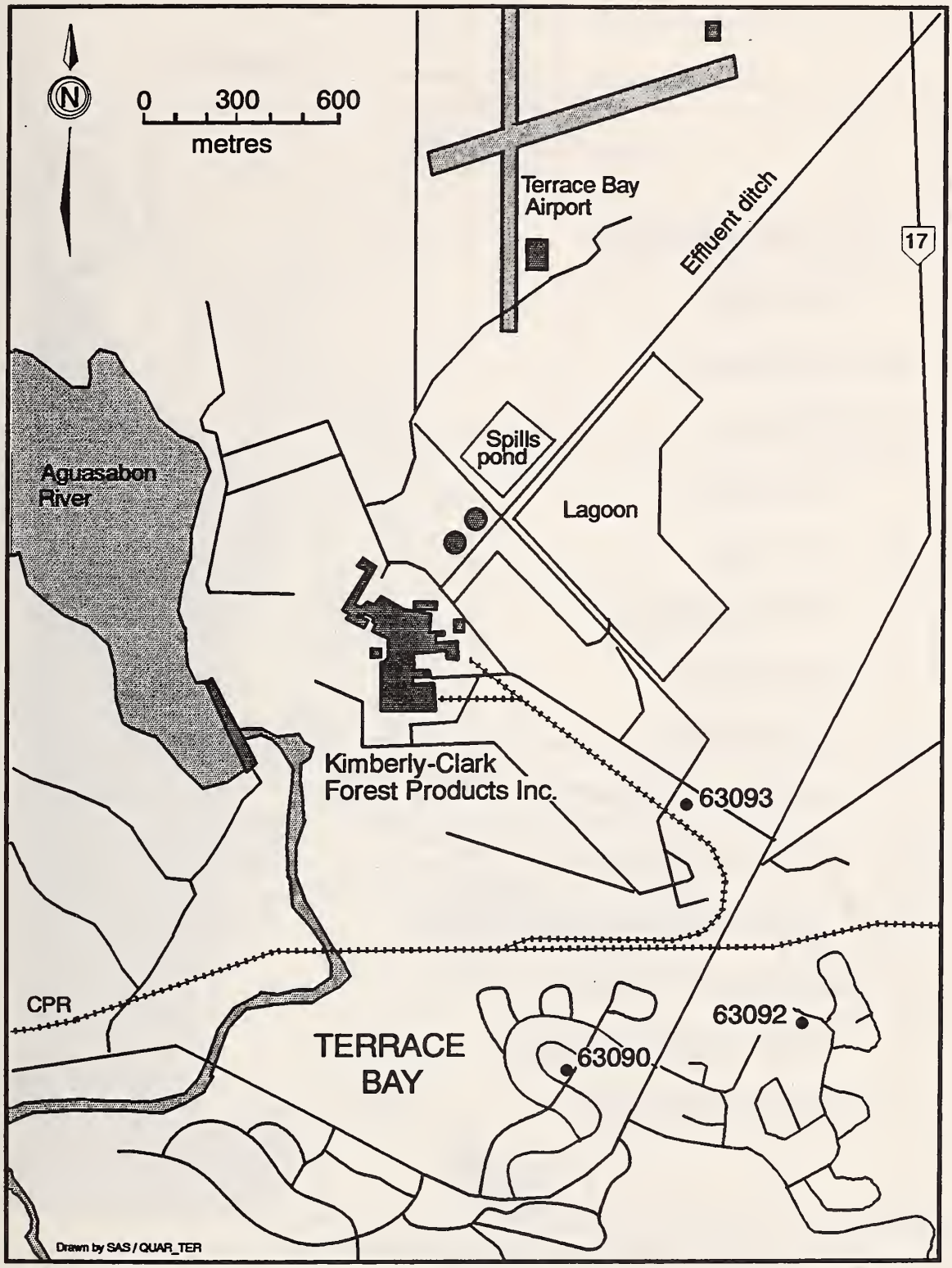

Figure 8. Air quality monitoring stations, Terrace Bay.

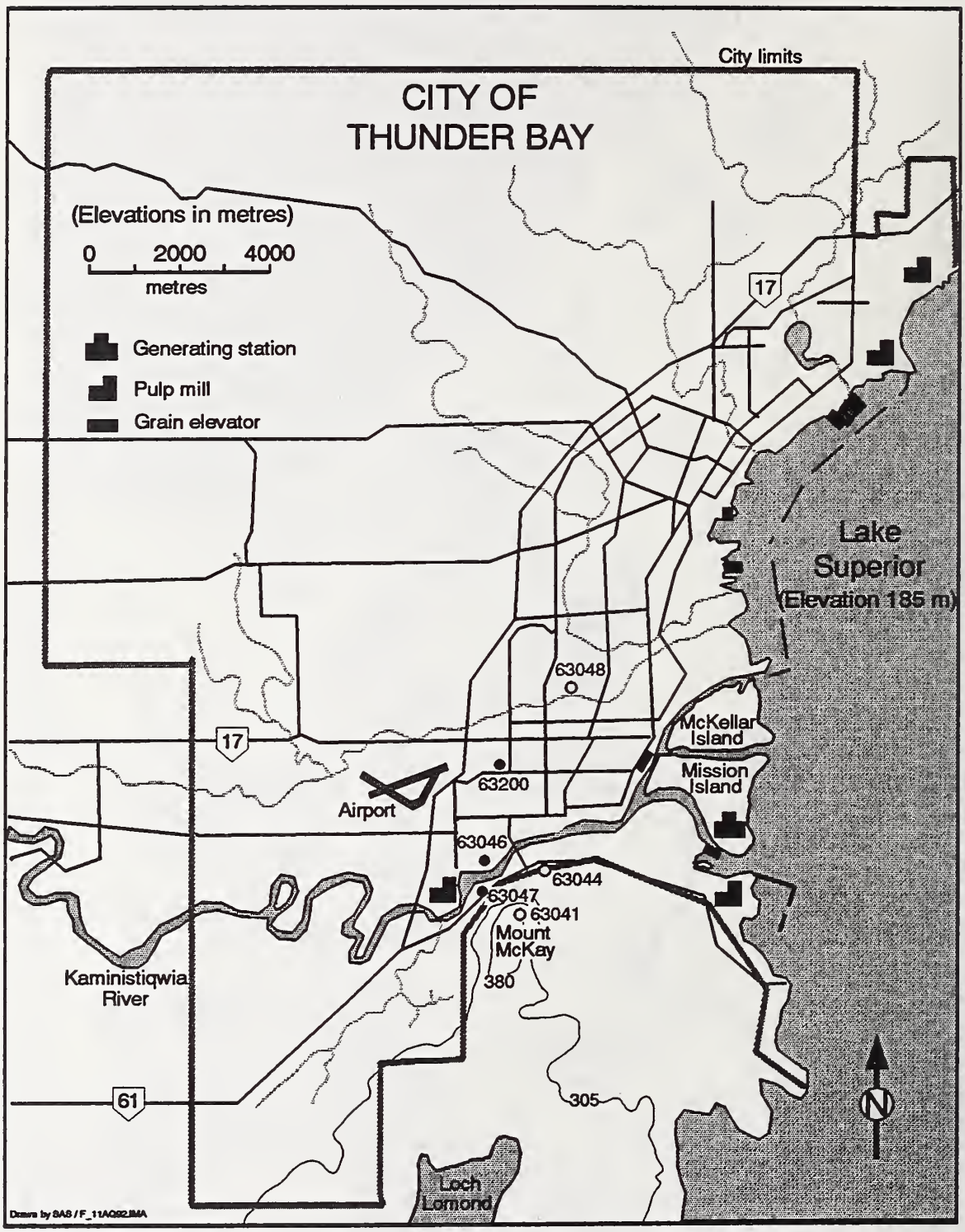

Figure 9. Air quality monitoring sites, Thunder Bay.
(o Ontario Hydro sites)

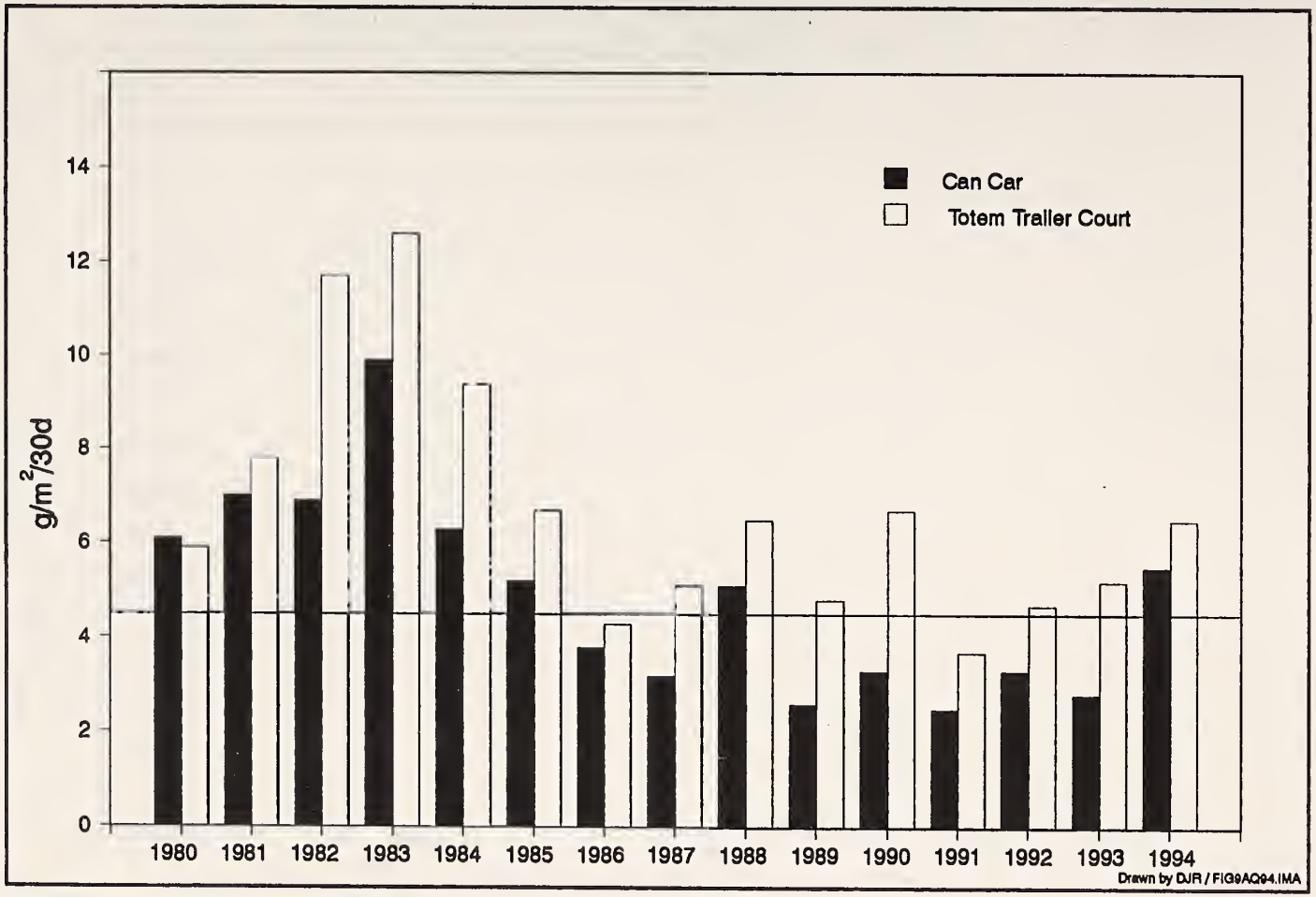

Figure 10. Total dustfall (g/m^2 /30d) near Avenor Inc., Thunder Bay.

TABLE 1. Air quality monitoring network, Kenora District, 1994.

Location	Station number	Parameters														
		Continuously monitored										Non-continuously monitored				
		Cl	SO_2	COH	CO	O_3	NO_2	TRS	Wind	Temp	AQI	TSP	PM10	PAH	VOC	Dustfall
DRYDEN	61027															
35 Van Horne Avenue								X	X	X						
FORT FRANCES																
Portage/Church	62030			X		X		X			X				X	
Cemetery	62032							X				X				X
Nelson/Portage	62033															X
First/Victoria	62034															X
Legion	62035											X	X[a]			X
Sinclair/Victoria	62036															X
Red/Gillon	62037															X
308 Sinclair Street	62046															X
Eighth Street	62047							X	X	X						
319 Nelson Street	62050															X
Hospital	62051	X						X								

[a] Filters analyzed for 19 parameters.

TABLE 2. Air quality monitoring network, Thunder Bay District, 1994.

Location	Station number	Parameters													
		Continuously monitored									Non-continuously monitored				
		SO_2	COH	CO	O_3	NO_2	TRS	Wind	Temp	AQI	TSP	PM10	PAH	VOC	Dustfall
CLOUD RIVER	63120				X										
ELY, MINNESOTA															
Fernberg Road	62068				X										
MARATHON															
CPR Station	63033						X	X							
RED ROCK															
Rec Centre	63084						X	X							
TERRACE BAY															
St. Martin's School	62090						X	X	X						
Terrace Heights Dr.	63092						X[a]								
Masonic Temple	63093						X[b]								
THUNDER BAY															
Can-Car	63046		X	X			X				X				X
Totem Trailer Crt	63047														X
James/Walsh	63200	X	X	X	X	X	X	X		X	X[c]	X[d]	X	X	

[a] Monitoring started 19 November.
[b] Monitoring terminated 7 November.
[c] Filters analyzed for nitrate, sulphate and lead.
[d] Filters analyzed for 19 parameters.

Table 3. Levels of arsenic (µg/g, dry weight) in trembling aspen foliage, Balmertown 1982 - 1994.

Site[a]	1982	1985	1990	1991	1994
1	9	4	9	5	2
2	12	6	15	5	3
5	60	11	12	13	4
6	36	14	33	21	18
7	5	3	3	4	3
9[c]	5	7	4	4	3
11	6	3	22	16	1
12[c]	13	4	4	6	2
13	68	31	440	73	99
14	26	17	29	14	4
17	16	6	5	8	8
20[c]	25	14	4	3	3
21	3	3	4	3	2
23	33	12	48	8	3
24[c]	25	6			
25[c]			12	14	5
28	510	60	38	14	26
32	820	17	16	41	10
Average, all sites	98	22	41	15	12
Controls	<1	<1	<1	<1	<1

[a] See Figure 1 for site locations.
[b] Values above guideline (2 µg/g) are underlined.
[c] Site within town boundary.

Table 4. Levels of arsenic (µg/g, dry, weight) in roadside manitoba maple and white elm foliage, Balmertown 1982-1994.

Site[a]	1982	1985	1990	1991	1994
			Manitoba Maple		
34	14	5	28	10	4
34	6	6	8	4	3
35	15	11	15	7	4
Average, all sites	11	7	17	7	4
Controls	<1	<1	<1	<1	<0.1
			White Elm		
33	7	4	11	6	4
34	8	7	9	6	3
35	13	12	11	7	7
Average, all sites	9	8	10	6	5
Controls	<1	<1	<1	<1	<1

[a] See Figure 1 for site locations.
[b] Values above guideline (2 µg/g) are underlined.
[c] Site within town boundary.

Table 5. Levels of arsenic (µg/g, dry weight) in soil (0-5 cm), Balmertown, 1975-1994.

Site[a]	1975	1978	1988	1994
1	1900	1100	880	660
2	190		400	230
5	3600	3400	1200	1100
6	800	1500	1000	1200
7	170	300	140	420
9[c]	320	310	81	100
11	390	310	240	400
12[c]	71	68	11	51
13	850	400	380	1000
14	660	230	750	790
17	300	520	2900	4700
20[c]	270	570	370	460
21	150	280	260	21
23	1000	330	1100	320
24[c]	1500	800	830	
25[c]				200
28		890	330	1100
32			2300	4700
Average, sites 1-25	810	720	700	780
Controls	18	9	8	9

[a] See Figure 1 for site locations.
[b] Values above guideline (20 µg/g) are underlined.
[c] Site within town boundary.

Table 6. Levels of arsenic (µg/l) in snow meltwater, Balmertown 1982 - 1994.

Site[a]	1982	1985	1989	1994
6	240	84	44	200
11				11
21				
28	590	500	190	540
33	14	40	100	47
34[c]			48	19
37			29	14
45	2600	1000	370	1000
48	86	51		40
Average, all sites	710	340	130	230
Controls	<1	<1	2	<1

[a] See Figure 1 for site locations.
[b] Values above guideline (30 µg/l) are underlined.
[c] Site within town boundary.

Table 7. Summary of concentrations (ppb) of total reduced sulphur, Dryden, 1987-94.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above interim standard
1987	346	0.5	26	0
1988	323	0.4	45	1
1989	362	0.4	20	0
1990	356	0.4	51	3
1991	365	0.3	21	0
1992	362	0.3	55	3
1993	350	0.3	21	0
1994	365	0.4	22	0

Table 8. Average sodium concentrations in unwashed Manitoba maple foliage, Fort Frances-International Falls, 1980, 1987 and 1990-94.

Site[a]	1980	1987	1990	1991	1992	1993	1994
1[b]	1800[d]	390	260	140	100	95	190
2[b]	1400	290	300	87	60	100	90
3[b]	1200	230	130	85	82	85	110
4[b]	620	110	120	81	92	100	170
5	260	100	100	47	37	60	95
6	390	300	150		47	100	60
9	150	240	78		49	75	65
13	83	140	61	24	19	30	30
14[c]	53	180	45	53	47	55	50
16[c]	73	150	51	44	42	40	50
18	120	220	44	42	59	40	65
20	250	370	44	30	31	45	30
21	250	200	39	26	27	30	36
22	140	430	60	36	40	50	35
23	280	140	55	60	39	35	40
24	210	65	62				
25	410	160	58	48	45	35	45
28		85	58	37	37	30	55
Average, all sites	460	210	95	56	50	60	72
Controls	100	38	19	22	25	22	25

[a] See Figure 3 for site locations.
[b] Sites on Boise Cascade Canada property.
[c] U.S. sites.
[d] Values above contaminant guideline (350 μg/g) are underlined.

Table 9. Average annual dustfall ($g/m^2/30$ d), Fort Frances, 1994.

Monitoring sites[a]	Total dustfall		Insoluble dustfall	
	1993	1994	1993	1994
62032	1.6	4.6	0.8	2.3
62033[b]	6.3	6.2	4.7	3.5
62034	3.1	3.8	1.9	2.6
62035	4.0	5.8	2.8	4.3
62036	5.5	6.9	3.8	5.3
62037	2.1	2.9	1.0	1.8
62046[b]	8.2	11.1	5.5	7.9
62050	3.3	4.8	1.9	3.0
Average, sites off mill property	3.2	4.8	2.0	3.2
% of total dustfall, off-property sites				67

[a] See Figure 2.
[b] Sites on company property.
[c] Values above the maximum acceptable limit (4.6 $g/m^2/30$ d) are underlined.

Table 10. Summary of total reduced sulphur concentrations (ppb) at stations 62030, 62052 and 62032, Fort Frances, 1977-1994.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above interim standard
		Station 62030/62052		
1977[a]	294	15.4	480	969
1978[a]	304	16.1	540	1035
1979[a]	344	10.2	353	911
1980[a]	352	9.3	499	872
1981[a]	277	12.0	279	806
1982[a]	320	8.8	543	685
1983[a]	336	4.9	254	418
1984[a]	332	2.8	98	135
1985[a]	363	2.0	191	87
1986[a,b]	335	3.9	226	300
1987[a]	359	5.5	278	431
1988[a,b]	359	5.9	268	552
1989[a,b]	365	5.0	126	414
1990[a]	360	5.5	159	493
1991[a]	365	4.3	235	251
1992[a]	366	4.2	234	310
1993[a]	365	4.2	219	329
1994[a]	361	2.4	98	76
		Station 62032		
1977	225	3.3	129	176
1978	281	2.5	134	141
1979	306	2.9	140	178
1980	307	3.3	124	210
1981	271	3.1	211	202
1982	269	2.1	99	115
1983	309	2.8	87	180
1984	314	1.9	74	38
1985	363	1.1	61	28
1986	325	1.2	133	37
1987	345	1.8	215	61
1988	363	1.7	160	84
1989	331	1.4	262	61
1990	365	1.2	85	43
1991	365	1.9	99	158
1992	366	0.8	47	10
1993	361	0.9	98	24
1994[a]	361	1.2	86	24

[a] Station 62030 [b] Station 62052

TABLE 11. Summary of total reduced sulphur concentrations (ppb) at stations 62047 (lagoon) and 62051 (hospital), Fort Frances, 1990-94.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above interim standard
			Station 62047	
1990	354	3.3	245	216
1991	363	3.0	235	171
1992	359	2.9	190	165
1993	348	1.9	112	73
1994	344	2.3	91	152
			Station 62051	
1990	325	2.1	104	56
1991	352	1.4	62	41
1992	348	1.3	70	44
1993	365	1.2	81	37
1994	357	1.0	58	13

TABLE 12. Summary of TRS concentrations (ppb), Marathon, 1989-94.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above interim standard
1989[a]	365	1.5	175	54
1990[a]	351	1.1	101	21
1991[a,b]	364	0.8	81	24
1992[b]	345	0.5	61	9
1993[b]	365	0.7	53	5
1994[b]	364	0.9	60	18

[a] Station 63034

[b] Station 63033

TABLE 13. Summary of TRS concentrations (ppb) at station 63084, Red Rock, 1990-94.

Year	Days of data	Annual average	Maximum 1-hour average	Number of hours above interim standard
1989	296	1.4	77	44
1990	344	1.6	83	80
1991	349	1.4	62	42
1992	340	2.0	110	89
1993	348	1.9	94	99
1994	349	3.2	92	250

TABLE 14. Summary of TRS concentrations (ppb) at stations 63090, 63092 and 63093, Terrace Bay, 1989-94.

Years	Days of data	Annual average	Maximum 1-hour	Number of hours above interim standard
			Station 63090	
1989	342	1.4	95	64
1990	365	1.3	65	51
1991	365	1.3	62	59
1992	366	1.7	117	96
1993	341	1.8	80	60
1994	365	1.1	89	30
			Stations 63092 and 63093	
1989[a]	344	4.4	180	373
1990[a]	351	2.7	381	204
1991[a]	360	4.4	236	379
1992[a]	359	4.9	243	404
1993[a]	342	5.7	327	503
1994[a]	308	2.1	126	85
1994[b]	45	1.3	53	9

[a] Station 63093; Monitoring terminated 7 November, 1994.
[b] Station 63092; Monitoring started 19 November, 1994.

TABLE 15. Total dustfall ($g/m^2/30$ d), Thunder Bay, 1994.

Station[a]	Location	Monthly Min	Monthly Max	Annual average
63046	Montreal Street	1.4	16.4[b]	5.5
63047	Totem Trailer Court	3.4	10.0	6.5

[a] See Figure 8.
[b] Values above maximum acceptable limits of 7.0 (monthly) or 4.6 (annual average) are underlined.

TABLE 16. Total suspended particulate matter ($\mu g/m^3$), Thunder Bay, 1994.

Station[a]	Number of samples[b]	Annual geometric mean[b]	Number of samples above 120 $\mu g/m^3$	Maximum
63046	53	40	2	167
63200	53	30	0	70

[a] See Figure 8.
[b] Data for May unavailable

TABLE 17. Summary of carbon monoxide, nitrogen dioxide and ozone concentrations (ppm) in Thunder Bay, and ozone at Cloud River and Ely, 1994.

	Station	Maximum 1-hour average	Maximum 8-hour average	Maximum 24-hour average
Carbon monoxide, Thunder Bay	63046	5.0	2.8	
Carbon monoxide, Thunder Bay	63200	8.0	4.5	
Nitrogen dioxide, Thunder Bay	63200	0.06		0.03
Ozone, Thunder Bay	63200	0.071		
Ozone, Cloud River[a]	63120	0.082		
Ozone, Ely, Minnesota[b]	62068	0.090		

[a] 30 km south-southwest of Thunder Bay.
[b] 180 km west-southwest of Thunder Bay.

TABLE 18. Summary of sulphur dioxide concentrations (ppm) in Thunder Bay, 1994.

	Location	Annual average	Maximum 1-hour average	Maximum 24-hour average
63200	615 S. James Street	<0.001	0.02	0.01
63041[b]	Mt. McKay		0.12	0.02
63044[b]	James St./Kam River		0.05	<0.01
63048[b]	Ford Street		0.05	<0.01

[a] See Figure 8 for station locations.
[b] Ontario Hydro. Air Quality Compliance Reports, 1993. Fossil Services Division, Environmental and Chemistry Department.

TABLE 19. Summary of total reduced sulphur concentration (ppb), station 63046[a], Thunder Bay, 1988-94.

Year	Days of data	Annual average	Maximum 1-hour average	Number of times above interim standard
1988	361	1.0	36	5
1989	343	1.0	51	2
1990	354	1.0	40	16
1991	362	1.2	60	19
1992	346	1.0	43	12
1993	349	1.0	51	11
1994	355	1.2	39	8

[a] See Figure 8 for station location.

TD/883.7/O5/A57/1994/MOE
Griffin, H.D.
Air quality
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